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Status of Atlantic salmon in Conne River, SFA 11, Newfoundland, 1997

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Abstract

Results obtained from a fish counting fence provided the basis for the assessment of the Conne River Atlantic salmon stock in 1997. Returns to home waters (river and estuary) were 3200 salmon < 63 cm in length and 185 salmon ≥ 63 cm in size. This represented a decrease of 28% for small salmon in comparison with 1996. Large salmon returns were similar to those of the previous year. Sea survival to 1SW salmon fell to the lowest level recorded (2.64%). Only 70% of the **Management Target** was met but 125% of the **conservation egg requirement** was attained. A mark-recapture study estimated a smolt run in 1997 of over 100,000, the highest to date. The commercial salmon fishery moratorium has had a negligible impact on the Conne River salmon stock. Salmon returns and sea survival rates continue to remain below levels experienced during the premoratorium period (1986-1991).

Résumé

Les valeurs obtenues à une barrière de dénombrement ont été utilisées pour l'évaluation du stock de saumon de l'Atlantique de la rivière Conne en 1997. Les remontées vers les eaux natales (rivière et estuaire) s'élevaient à 3 200 saumons de moins de 63 cm de longueur et à 185 saumons de 63 cm ou plus. Cela représente une baisse de 28 % des petits saumons par rapport à 1996. Les remontées de grands saumons ont été semblables à celles de l'année précédente. La survie en mer des saumons UBM est tombée à la plus faible valeur jamais enregistrée (2,64 %). L'**objectif de gestion** n'a été atteint qu'à 70 %, mais la **ponte de conservation** a été atteinte à 125 %. Une étude par marquage-recapture a permis d'estimer une descente de saumoneaux de plus de 100 000 poissons en 1997, soit la valeur la plus élevée obtenue jusqu'à maintenant. Le moratoire imposé à la pêche commerciale du saumon a eu un effet négligeable sur le stock de la rivière Conne. Les remontées et les taux de survie en mer demeurent inférieurs aux valeurs obtenues pendant la période précédant le moratoire (1986-1991).

Introduction

Conne River, SFA 11 (Fig. 1) flows into Bay d'Espoir on the south coast of insular Newfoundland. It is a sixth-order river with a drainage area of 602 km^2 and a total length of 193 km. Since 1986, a fish counting fence has been operated to enumerate the upstream migrating population of Atlantic salmon (*Salmo salar*). Mark-recapture studies were initiated in 1987 to survey the number of migrating smolts. These operations continued in 1997. Previous estimates of total returns of small salmon have ranged from a low of 1533 in 1994 to 10155 in 1987.

Conne River is currently managed against a Management Target (MT) which differs and is higher than the conservation requirement. The Management Target was based upon the estimated number of spawners required to produce the highest recorded returns to the river, which occurred in 1987. The returns were adjusted to account for the total population prior to any sea fisheries by using an assumed commercial exploitation rate.

The Management Target was met or exceeded from 1986-90, but declined to 40% in 1994 (Dempson MS 1993; Dempson et al. MS 1994; Dempson et al. MS 1995). Stocking of reared fry in 1995, from brood fish maintained in 1994, increased the 'equivalent' egg deposition in 1994 to 58% of the Management Target. Increased sea survival over the 1994-95 period resulted in 81% of the Management Target being met in 1995 (Dempson and Furey MS 1996). Smolt production has varied from a low of about 56000 in 1993 to a high of 94000 last year (1996) ($\bar{x}$ = 68716, coefficient of variation, C.V. = 16.5%).

A major change in the management of the Conne River Atlantic salmon stock for 1993 was the complete closure of the recreational fishery. In light of the forecast of low salmon returns in 1994 and 1995, this closure was continued and extended to the Indian Band Council's food fishery. Both fisheries remained closed in 1996 but limited food and recreational fisheries were allocated for 1997.

Expectations for 1997

Several factors suggested that returns in 1997 should have been similar to or higher than returns in 1996. These factors included: (a) the largest smolt run to date in 1996; (b) early spring conditions favouring an early smolt run which in past years coincided with better marine survival; (c) a higher marine thermal habitat index for January-March 1997, which similarly suggested improved survival; and (d) the observation that sea survival from smolts to returning small salmon had increased in each of the past several years following the lowest value recorded that was associated with returns in 1994 (Dempson and Furey MS 1997). We note that the Stock Status report for the Conne River area (SFAs 9-11; DFO Science Stock Status Report D2-04) indicated that "***with survival similar to that for 1SW salmon in the previous year, then returns should easily exceed 4000 fish*** ...". The emphasis was on if survival was the same, but the report also cautioned that any consideration for harvests should be done pending in-season reviews. The Stock Status Report also cautioned that south coast stocks, including Conne River, had not shown

any consistent improvement in returns during the moratorium years and thus there was still concern about the health of these stocks.

This paper summarizes smolt production and returns of adult Atlantic salmon to Conne River in 1997. In addition, information on environmental characteristics during the 1997 season is provided, and biological characteristic data for Atlantic salmon are updated. Results from the 1997 season are addressed relative to the Management Target as well as the conservation egg deposition requirement as in 1996.

Noteworthy events or changes in 1997

The following summarizes noteworthy changes to fishery regulations and other observations/events occurring in 1997:

- recreational and native food fisheries were opened again in 1997;
- sea survival from smolts to 1SW salmon was the lowest value recorded (2.64%);
- only 70% of the Management Target achieved in 1997; however, 125% of the conservation egg requirement was attained;
- there were no 2SW salmon returns from the sea cage rearing experiment initiated in 1995 using wild Conne River smolts;
- smolt production in 1997 exceeded the 1996 value and was the highest on record.

Methods

1. Landings

Information on recreational catch statistics were collected by Department of Fisheries and Oceans (DFO) guardians. Landings from the native food fishery were obtained from the Conne River Native Band Council.

2. Environmental conditions

Water temperature information was obtained from a continuous recording Hugrun thermograph located in the lower Conne River (May 2 - September 11, 1997) (Fig. 2). Information on air temperature, precipitation, and discharge were obtained from the Provincial Water Resources Management Division monitoring facility located on the main stem of Conne River, below Conne Pond.

3. Biological characteristics

Biological characteristic data on adult salmon, including fork length, whole weight, age, and fecundity were derived from sampling salmon captured at the fish counting fence and from

sampling fish caught in the recreational fishery. Adult salmon samples were also obtained from the food fishery. Biological data on Atlantic salmon smolts were obtained from specimens sampled at the downstream fish counting fence trap.

Estimates of the numbers of salmon of different life stages (1SW, 2SW, consecutive and alternate spawners) that have returned to Conne River were derived following methods reported in Dempson and Reddin (MS 1995). Salmon returning to the river are categorized as small (< 63 cm) or large (≥ 63 cm) salmon. Biological characteristic data were similarly partitioned into these respective size classes and applied to numbers of returning fish. Data were available for 2025 small salmon, but only 80 large salmon. For small salmon, year specific information was applied from 1986 to 1990, and 1995-1997. Note that a correction for some fish aged in 1987 has resulted in different values for some years in comparison with that reported in the past. For years 1991-1994, the average contribution for the years 1986-94 were used. With respect to large salmon, numbers from 1986 to 1997 were recalculated using the average values for the 1986-1997 period. Survival of repeat spawning salmon was determined by adding the subsequent estimates of consecutive spawners in year $i+1$ for both small and large salmon with the number of alternate spawners in year $i+2$. This value was then divided by the corresponding estimated number of 1SW fish from year i. Consecutive or alternate spawners, then, are all assumed to be associated with the previous 1SW component by a time span of either one or two years.

Condition of smolts was determined using Fulton's condition factor (K) as follows:

$$K = W \times C / L^3$$

where, W = whole weight in grams; C = a constant, 100,000; and F = fork length in mm.

4. Estimated returns and spawning escapement

Adult Atlantic salmon migrants were enumerated at a fish counting fence, located about 1 km upstream from the mouth of the Conne River (Fig. 1), which operated from May 29 to September 4, 1997 (Table 1). The counting fence was monitored as a co-operative project between DFO and the Conne River Indian Band.

During 1997, adult salmon were counted either as they: 1) passed through monitored openings in the fish counting fence; 2) entered the trap directly; or 3) passed through openings in the fish counting fence but were recorded on the video camera system. The video camera system utilized a positive image horizontally directed camera (Panasonic model WV-BD400) positioned on the substrate and angled to view an opening in the fish counting fence. A Panasonic Time Lapse Video Recorder (Model AG 6040) was used to record the video signal from the camera and could also superimpose the time and date thus providing a summary of actual fish passage times. The video system was operated each day generally from early evening until about 0900 hours from June 13 until August 6.

Total river returns

Total river return (TRR) of adult salmon was estimated from:

$$TRR = C + Mb + Cn$$

where,
- C = the count of salmon at the counting fence
- Mb = the known mortalities below the counting fence, and
- Cn = the estimated catch of Conne River origin salmon in the native food fishery (514 x 0.833).

Spawning escapement

Spawning escapement (SE) was estimated as:

$$SE = FR - Ma - Br$$

where,
- FR = the number of fish released at the counting fence
- Ma = the number of known mortalities above the fence
- Br = the number of salmon removed for brood stock use.

Consistent with the practise established in 1991, estimated egg deposition refers to the 'potential' deposition relative now to either the current **Management Target** or the **conservation egg requirement**. That is, no additional adjustments have been made to account for any unknown or assumed mortality of fish up to the time of spawning. Thus, the potential egg deposition could overestimate the actual egg deposition.

Egg deposition

As in past years, egg deposition (ED) was calculated separately for salmon < 63 cm and salmon ≥ 63 cm and then totaled.

$$ED = SE \times PF \times F$$

where,
- PF = proportion of females
- F = fecundity at size

An estimate of fecundity was obtained from the relationship derived in 1987 (October 27-30) from ripe salmon (Dempson et al. MS 1987):

$$\text{Fecundity} = 0.1988(\text{fork length, cm})^{2.3942} \qquad (r^2 = 0.48, P < 0.001)$$

where fork length was the mean length of female salmon < 63 cm. For 1997, the mean length and proportion of females from all years were used ($\bar{x}$ = 50.8 cm; N = 1232, and includes repeat spawning females < 63 cm; percentage female was 78%).

An estimate of the egg deposition from salmon ≥ 63 cm in size was obtained using the same length-fecundity relationship for salmon < 63 cm, with the same data for mean length (67.8 cm) and percent females (71%) as used in past years (Dempson MS 1989, MS 1990).

The **Management Target** has been maintained as in past years at **7.8 million eggs**. This was equivalent to about 4000 salmon < 63 cm in size.

In order to compare correctly and evaluate Conne River against other Newfoundland salmon rivers for which stock assessments are done, a corresponding **conservation egg requirement (ER)** was been calculated. The calculation follows methods summarized in O'Connell and Dempson (1995) for average potential smolt production:

fluvial habitat	=	13180 units @ 3 smolt/unit
lacustrine habitat	=	3187 hectares @ 7 smolt/unit

Corresponding egg deposition requirements were derived using egg-to-smolt survival rates of 0.0125 and 0.019 for fluvial and lacustrine habitats, respectively. The **conservation egg requirement** then, equals **4,337,358** eggs versus 7.8 million as a **Management Target**.

The equivalent total number of spawners (TNS) associated with the **conservation egg requirement** was calculated as follows:

$$TNS = \frac{ER}{[\,(PS \times PF_s \times F_s)\,]}$$

where,

PS	=	proportion small salmon (< 63 cm) in TRR, 1992-96 (= 0.958)
PF_s	=	proportion female small salmon, 1992-96 (= 0.769)
F_s	=	fecundity of small salmon at size ($\bar{x}$ length, 1992-96 = 50.5 cm, = 2379)

Thus, TNS = 2475 small salmon.

5. Net-marked and escaped farmed Atlantic salmon

Surveys of net-marked salmon returning to Conne River were carried out from June 7 - July 20, 1997, but only on those fish clearly observed in the fish counting fence trap. From salmon observed in the counting fence trap, those fish with characteristic 'farmed fish' appearance (fin size, shape and form, body shape and pigmentation) were noted and removed to a holding

cage upstream from the counting fence trap. Identity of these fish was subsequently confirmed by examination of scale circuli characteristics.

6. Smolt production

A mark-recapture study was carried out to estimate the smolt production in 1997. The study was similar to those carried out in 1987-96, the design of which is summarized in Dempson and Stansbury (1991) and uses the estimator described in Schwarz and Dempson (1994). As in 1995 and 1996, the downstream smolt trap was monitored 24 hours of the day.

During 1997, 3715 smolts were tagged and released at the upstream partial counting fence site (Fig. 1). At the downstream recapture site, 18290 smolts were caught including 662 tagged smolts.

7. In-season and pre-season forecasts of salmon abundance

In-season forecasts

In-season forecasts of small salmon abundance were generated from regressions of counts to date versus total count for the year to infer whether the Management Target would likely be attained. Eleven years of data (1986-1996) were available. Various in-season dates were chosen starting from June 18 until July 5. Last year (Dempson and Furey MS 1997), a retrospective analysis of this approach indicated that incorrect 'advice' would have been produced in about 7.6% of the cases going back to 1986. However, in all of these cases, the incorrect 'advice' would have erred on the side of conservation. Thus, the utility of this approach for Conne River, at least, had some merit for use in 1997.

Pre-season forecasts

Previously, two pre-season forecasts were examined for Conne River. The first was derived from a relationship between the median date of smolt run timing and subsequent survival to 1SW salmon. The second forecast is based on a relationship between an index of marine thermal habitat (Reddin and Friedland 1993; Dempson and Reddin MS 1995) and subsequent survival to 1SW salmon. Scatter plots only of updated information are provided; no pre-season forecasts are given.

Results and Discussion

1. Landings

Landings in the recreational fishery are summarized in Table 2. As indicated above, a limited recreational fishery resumed in 1997 under an initial quota of 200 small salmon. We note that in past years, angling exploitation rates varied from 0.181 to 0.285 (Dempson et al. MS

1994). During the period of time that the recreational fishery was opened in 1997, the exploitation rate was 23.9% (recreational fishery open from June 21 to June 26, 1997).

Native food fishery catches are summarized in Table 2. In 1997, the Conne River Band was authorized to harvest 600 Atlantic salmon up to June 22, and pending an inseason review of the status of the Conne River stock, a decision to either close the fishery or allow further harvesting would be made. The fishery opened June 2 and closed on June 25; 514 small salmon and one (1) large salmon (dead in trap) were reported captured. Six other large salmon were released alive.

2. Environmental conditions

In contrast with 1996 when the mean air temperature for April was the warmest since 1988, the average April 1997 air temperature was the coldest during the 1986 to 1997 period. May air temperatures were the third coldest over this time interval whereas an air temperature index for the period April 1 to May 15, was also the coldest since 1988 (Fig. 3b). Air temperatures in 1997 remained cool into June; the first day with an mean daily temperature of over 10° C was June 9. Water temperatures (Fig. 2) similarly were cool into early May. May 16 was the first day when the average temperature was over 10° C at the lower fish counting fence (Hugrun thermograph), but not until June 1 at the outlet of Conne Pond. Cooler temperatures contributed to the latest smolt run timing to date at Conne River. Note that mean April temperature explained 65% of the variation in smolt run timing (median) at Conne River while the mean April 16 - 30 air temperature explained 74% ($P = 0.0007$) of the variation.

	Mean air temperature				Median day of smolt run timing
Year	April	May	April 1 - May 15	April 16 - 30	
1986	5.11	7.70	5.60	8.51	-
1987	4.11	8.15	5.48	4.37	131
1988	3.18	10.08	4.77	3.55	136
1989	2.69	8.90	4.08	3.01	138
1990	2.28	6.36	3.46	2.72	138
1991	1.16	5.95	2.87	3.25	141
1992	0.36	7.77	2.36	0.67	145
1993	1.49	6.87	2.34	3.35	143
1994	1.17	6.21	2.69	2.28	142
1995	0.49	5.56	1.80	2.54	139
1996	3.09	5.82	3.69	5.02	124
1997	-0.36	5.87	1.59	0.43	146
1998	2.08	8.23	4.31	3.34	-

Water temperatures increased over the summer with the warmest temperatures occurring in early July and again in early August (Fig. 2). During the period May 2 - September 11, mean daily temperatures exceeded 20 °C on only ten occasions (Fig. 2). The maximum water temperature occurred on July 9 (24.3 °C).

Water levels were generally low during much of June, July and August (Fig. 2). In early September (Sept. 4-5), approximately 100 mm of rain fell with a corresponding sharp increase in discharge. This discharge event terminated the operation of the Conne River fish counting fence in 1997. We note, however, that only 32 salmon (21 small; 11 large) had been counted since July 31; the small number of salmon encountered after the end of July being consistent with that experienced in past years.

3. Biological characteristics

Adult samples

Table 3 summarizes annual biological characteristic data of Atlantic salmon from Conne River, 1986-1997. Mean weight of 1SW salmon in 1994 and 1995 is lower by comparison with earlier years. This may have been because measurements were taken from salmon maintained in cages for brood stock and were recorded in September rather than in June or July as in past years.

Repeat spawning salmon are separated into consecutive and alternate categories. Consecutive spawners are typically less than 63 cm in fork length ($\bar{x}$ = 574 mm, Table 3) while alternate spawners average 694 mm in length (Table 3) (Fig. 4). As acknowledged in past reports, not all size classes of fish can be sampled representatively. However, with respect to salmon less than 63 cm in length, only 115 (5.68%) out of 2025 samples at Conne River were either consecutive (N = 114) or alternate (N = 1) spawning fish. Length-frequency distributions of 1SW, 2SW, consecutive, and alternate spawners sampled at Conne River are illustrated in Figure 4.

Biological characteristics of Atlantic salmon captured in the aboriginal food fishery are presented in Table 4. Mean length and weight of salmon caught 1997 were greater than in previous years, especially the mean weight. Reasons why salmon were several hundred grams heavier in 1997 are unknown.

Survival of repeat spawning salmon was less than 10% until 1994 (Table 5). Since then, the contribution of repeat spawners has changed dramatically (Table 5). Even without the contribution of alternate spawning salmon in 1998 added in, estimates of the number of consecutive repeat spawners in 1997 from 1SW salmon in 1996 will yield a survival of over 20%. Repeat consecutive spawners at Conne River have been found to enter the river later, in general, than virgin grilse. As in 1996, samples obtained in 1997 were taken over much of the run. In contrast, repeat alternate spawners (mostly large salmon) tend to be found more in the earlier part of the run.

Few repeat spawning salmon were identified in the scale samples obtained from the food fishery (N = 476) (Table 4). This fishery closed June 25. Given the lack of repeat spawners in the food fishery samples, it suggests that when the repeat spawners return to home water areas, they enter rivers directly without spending extended periods in the local marine and estuarine areas.

O'Connell et al. (1997) recently examined inter-annual variation in fecundity for a variety of Newfoundland salmon rivers, including Conne River. Data (N = 459) from small salmon at Conne River were available from six years (1986 - 1988, 1990 - 1992) and were expressed in terms of number of eggs per female, as well as relative fecundity in terms of weight and length (Table 6). It was noted that there was a substantial decline in fecundity from 1988 to 1992 at Conne River. Information obtained in 1997 has now been added to the time series. As indicated in Table 6, following the low fecundity values during the early 1990's, fecundity in 1997 was the highest recorded.

Smolt samples

Smolt condition (Fulton's condition factor) has ranged from a high of 0.98 in 1987 to a low of 0.89 in 1992 (Fig. 3a). Smolt condition has declined in each of the past several years, and in 1997 condition was the lowest since 1990 and slightly less than the overall mean for all years combined. Previously, it was noted that years in which smolts had a higher condition were often those that were associated with warmer spring temperatures (Fig. 3c). There was also an indication that smolt condition was associated with subsequent sea survival, as higher survival of smolts often occurred in years where condition was greater (Fig. 3d).

Farmed (hatchery) salmon

Four hundred and thirty (430) salmon were observed in the fish counting fence trap during 1997 for either net marks/scars or for evidence of external features characteristic of escaped aquacultured fish. Of these, 8 salmon were identified (externally) as escaped farmed salmon (1.86%) and were held in a cage upstream from the fish counting fence trap. From a sample of 237 small (N = 212) and large (N = 25) salmon sampled for ages, only two (2) fish (0.84%) were identified as escaped farmed salmon. Of the eight fish held in the cage, 5 (3 small and 2 large) were sacrificed. Three (3) fish escaped from the cage when the cage top was torn off during the storm in September. From the aged samples obtained from the Aboriginal food fishery (N = 480), 4 fish (0.83%) were identified as being of farmed (hatchery) origin.

Run timing

Figure 5 illustrates the run timing (median date) of smolts and adult small salmon at Conne River. Variability in run timing is apparent for both groups with up to a 21 day difference in the 25th percentile of the run of smolts and 15 day difference in timing of small salmon returns. Median dates of the smolt run were typically later (7 days) during 1991- 1994 (May 21) in comparison with the pre-1990 period (May 14); the earliest smolt run occurred in 1996 while the latest run was in 1997. Recall that 65% of the variation in timing of the smolt run can be explained by the mean April air temperature (Section 2 - Environmental conditions). The

distributions of each of the annual smolt runs are shown in Figure 6. As discussed in previous years, smolt run timing has been associated with subsequent survival to 1SW salmon. This pattern was not consistent with results in 1997.

Rainbow trout

Updated records on the numbers of rainbow (steelhead) trout encountered at Conne River are provided in Table 7. Previous occurrences are reported in past assessment reports.

4. Estimated returns and spawning escapement

There were 2676 salmon < 63 cm and 184 salmon ≥ 63 cm counted at the fish counting fence on Conne River in 1997 (Tables 8 and 9). This represents a decrease of 40% in the number of small salmon in comparison with 1996. Large salmon numbers were similar to the previous year. The single largest daily run occurred on July 11 (234 small salmon) (Fig. 7) and about 95% of the run of small salmon was complete by July 15. The distributions of past annual small salmon counts are also shown in Figure 7.

Partitioning the count of salmon among the various ways fish were enumerated in 1997 is as follows:

	Small Salmon		Large Salmon	
	N	%	N	%
Fence opening	0	0	0	0
Counting fence trap	524	20	68	38
Video camera chamber	2152	80	116	64
Total	2676	100	184	100

With respect to the video camera system, salmon generally migrated all night long. During 1997, the period from 2230 to 0229 hours accounted for 66% of the total. This pattern of movement was generally consistent with that observed at Conne River in past years. A total of 1520 fish were associated with time of fish passage as follows:

Time (hours)	Number of fish	%
2030 - 2229	439	29
2230 - 0029	381	25
0030 - 0229	325	21
0230 - 0429	299	20
0430 - 0900	76	5

Total returns (Fig. 8) of adult salmon to Conne River in 1997 are summarized in Tables 8 and 9 for small and large salmon, respectively.

Total returns of small salmon (3200) were 28% lower than in 1996 while large salmon returns (185) were essentially the same as 1996. There were no apparent returns of 2SW salmon in 1997 from the wild aquacultured fish that were released as 1SW salmon in 1996 (Dempson et al. MS 1997).

Sea survival

Sea survival from smolts to small salmon has varied from 2.7 to 10.2% (Table 10). Survival had increased from 2.7% (2.6-3.0%) in 1994 (return year) to 7.2% (6.4-8.3%) in 1996 but subsequently decreased dramatically to 3.4% (3.0-4.0%) with the 1997 returns (Fig. 9, Table 10). Corresponding sea survival to 1SW salmon fell to the lowest value recorded (2.64%).

Potential spawning escapement in 1997 was estimated to be 2558 small salmon and 182 large salmon (Tables 8 and 9). Mean number of eggs per female for the wild salmon was 2413 using average size data of females for all years.

small salmon = 4.81451 million eggs
large salmon = 0.62245 million eggs

for a total egg deposition of 5.43 million, or 70% of the current **Management Target** or 125% of the **conservation egg requirement** (Table 9).

Relationships between estimated egg deposition and subsequent smolt output were based on limited data and as such, have not been conclusive. Previously, higher egg depositions produced more smolt; this pattern has now changed with the low egg deposition from 1992 (~4 million eggs) that has already produced over 75 thousand smolts to age 3+.

Estimates of egg-to-smolt survival are now available for seven year-classes (1986 to 1991; the 1992 year-class complete only to age 4 smolts in 1997). These values, by year-class, are:

Year-class (eggs)	Estimated egg deposition	Smolt Production	Survival (%)	Number of eggs per 100 m²
1986	11340000	56873	0.50	860
1987	16730000	76655	0.46	1269
1988	12420000	65038	0.52	942
1989	8040000	55335	0.68	610
1990	8730000	68720	0.79	662
1991	3980000	57793	1.45	302
1992	3970000	(95083)[1]	2.40	301
1993	4760000			361
1994	3120000			237
1995	6320000			480
1996	8730000			662

[1] to age 4 smolts in 1997

Egg-to-smolt survival, has more than doubled from the average of the 1986 to 1990 values (mean = 0.59%). The dramatic increase in the egg-to-smolt survival coincided with the first of several successive years in which the egg depositions were below the conservation requirement of 7.8 million eggs. Similarly, egg deposition in 1993 was also well below the Management Target of 7.8 million eggs. Smolts produced to date from the 1993 year class are now complete to age 3, and egg-to-smolt survival is already 1.7% and should easily exceed 2% again. Last year we noted that egg-to-smolt survivals have increased coincident with the decrease in the egg deposition rate per unit of fluvial habitat.

5. Net-marked salmon

The following summarizes observations of net marked fish at Conne River during 1997.

Date	Number of fish observed	Number scarred	Percent Scarred
June 7-16	33	1	3.0
June 17-21	22	2	9.1
June 22-26	8	0	0.0
June 27-July 1	117	13	11.1
July 2-6	47	2	4.3
July 7-11	166	10	6.0
July 13-20	37	3	8.1
Total	430	31	7.2

Numbers of net marked salmon varied on each occasion with no apparent increasing or decreasing trend. Results are comparable with those obtained in past years.

6. Smolt production

The estimated number of smolts in 1997 was 100,983 (95% confidence limit = 92812-109154) (Table 10). This was the highest production estimated from Conne River and was largely derived from the 1993 spawning escapement which was estimated to have produced about 4.8 million eggs. The number of smolts in each age group is summarized in Table 11. There were no farmed smolts identified in the sample of Conne River salmon smolts removed for biological characteristic information in 1997.

7. In-season and pre-season forecasts of salmon abundance

In-season forecasts

As explained in the Introduction, a number of pre-season indicators suggested that salmon returns in 1997 should have been at least similar to those in 1996 if not better (high smolt run; early run timing; improved thermal habitat; increased sea survival in recent years). Until the first in-season review was conducted, this position had been maintained.

Based on relationships of cumulative counts at various in-season dates with subsequent total counts for past years, it has been possible to infer whether the Management Target would likely be attained relatively early in the season. The first indicator that salmon returns to Conne River in 1997 could possibly be low was available by June 18, 1997. As it turned out, only 7.1% of the run of small salmon had past through the fish counting fence by that date, but the in-season 'prediction' suggested that approximately 2950 salmon would return. 'Formal' in-season advice was based on information to and including returns to June 23, 1997. At that time, 530 small salmon had been counted (19.8% of the total count) and an in-season 'forecast' suggested that the Management Target would not be attained (about 2850 salmon returning to the fence) but it was likely that the conservation egg requirement would be met. On the basis of this advice, both the recreational and food fisheries were closed. This in-season forecast was correct; the June 23 forecast was within about ± 10% of the final fence count.

Figure 9 illustrates the updated sequential regressions of in-season counts to various dates with the corresponding total run for the year beginning with June 18. At Conne River, the cumulative count to June 18 has ranged from a high of 33.8% of the total run in 1987 to a low of 2.0% in 1990. For all in-season dates, the relationship is highly significant (Fig. 9). As expected, the r^2 value increases as the season progresses as more and more of the final total is being accounted for. We note again that corrections for salmon taken in food fisheries or recreational fisheries have not been factored into the numbers used; only actual returns to the fish counting fence. Based upon these relationships, by June 18 approximately 650 small salmon, or about 1400 small salmon by June 23 would have to have passed through the fish counting fence to

suggest that the Management Target of 4000 fish will be attained assuming that the run in 1998 would have similar characteristics as the pattern observed in past years.

Pre-season forecasts

Previously, relationships between sea survival to 1SW salmon with: (a) median timing of the smolt run from the previous year; and (b) an index of marine thermal habitat (January-March) had indicated some utility to infer subsequent salmon abundance. These relationships did not hold with the 1997. This is typically a sign of model instability when models are based on relatively little data. Updated scatter plots of these relationships with information from the 1997 season included are provided in Figure 10. Updated values of marine thermal habitat for the period January to March, 1998, are summarized in Table 12. We note that the thermal habitat values are the highest recorded in this time series. No pre-season forecasts are provided.

8. Fry stocking

Some adult salmon from the experiment using aquacultured smolts (Dempson et al. MS 1997) were maintained to compare egg quality and subsequent fry survival. The fry progeny from these fish were stocked in Hotwanic Brook during the spring of 1997. Hotwanic Brook empties into the main stem of Conne River and is inaccessible to upstream migrating Atlantic salmon due to natural obstructions. Approximately 22,700 fry were stocked. The following summarizes past fry stocking at Conne River:

Broodstock		Fry stocked		
Year removed	N	Year	Number	Location
1994	93	1995	128,000	Twillick Bk.
1995	117		No fry were stocked	
1996	25	1997	22,700	Hotwanic Bk.

Of the 128,000 fry stocked in 1995, approximately 40,000 were stocked as fall fed fingerlings.

We note that recent analyses of microsatellite DNA variation in the Conne River stock has suggested there are significant differences in allele frequencies among the major tributaries (Beacham and Dempson 1998).

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Table 1. Summary of dates of operation for downstream smolt mark-recapture studies, and upstream adult salmon counts at Conne River, Newfoundland.

Year	Smolt mark-recapture studies		Adult salmon counts	
	Start	Finish	Start	Finish
1986			May 12	Sept 10
1987	April 26	June 16	May 18	Sept 8
1988	May 9	June 14	May 21	Aug 29
1989	May 9	June 15	May 20	Aug 28
1990	May 3	June 20	May 23	Aug 6
1991	May 3	June 16	May 26	Aug 18
1992	May 10	June 15	May 26	Aug 10
1993	May 9	June 14	May 28	July 31
1994	April 28	June 18	June 1	Sept 25
1995	May 2	June 8	May 30	Oct 16
1996	April 26	June 11	May 21	Sept 23
1997	May 15	June 15	May 29	Sept 4

Table 2. Atlantic salmon landings (in numbers of fish) in the recreational fishery, 1974-1997, and in the native food fishery, 1986-1997, at Conne River, Newfoundland. Note that the recreational fishery was closed from 1993 - 1996 while the food fishery was been closed from 1994 - 1996.

	Recreational Fishery				Native Food Fishery			
	Effort	Salmon catch				Salmon catch		
Year	rod-days	Small	Large	Total	Quota	Small	Large	Total
1974	4033	1988	17	2005				
1975	3800	1903	17	1920				
1976	3894	1931	27	1958				
1977	3375	1665	5	1670				
1978	3122	1735	7	1742				
1979	2147	1010	0	1010				
1980	3512	2238	14	2252				
1981	5029	2691	2	2693				
1982	5268	3302	24	3326				
1983	6972	2192	21	2213				
1984	6709	2343	0	2343				
1985	5202	2729	0	2729				
1986	6038	2060	0	2060	1200	519	3	522
1987	4979	1598	0	1598	1200	18	0	18
1988	5504	1544	0	1544	1200	607	2	609
1989	4414	1036	0	1036	1200	381	1	382
1990	2740	767	0	767	1200	948*	11	11
1991	679	108	0	108	1200	281	3	284
1992	1499	329	0	329	1200	483	5	488
1993	0	0	0	0	500	417	3	420
1994	0	0	0	0	0	0	0	0
1995	0	0	0	0	0	0	0	0
1996	0	0	0	0	0	0	0	0
1997		197	0	197	600	514	1	515

* Total for 1990 does not include approximately 50 fish found dead and partially destroyed in traps.

Quotas of 100 and 330 small salmon were in effect for the recreational fishery in 1991 and 1992, respectively.

Initial food fishery allocation pending an inseason stock status review was for 600 small salmon.

Table 3. Summary of biological characteristics for Atlantic salmon samples from Conne River, Newfoundland (SFA 11), 1986-1997.

Lifestage	Year	Fork length (mm)					Whole weight (g)					River age (y)					Sex Ratio	
		N	Mean	SD	Min	Max	N	Mean	SD	Min	Max	N	Mean	SD	Min	Max	N	% female
Smolt	1986	145	153	12.0	125	210						145	3.25	0.48	2	5		
	1987	271	144	16.5	106	198	271	29.1	9.9	11.5	73.8	271	3.32	0.54	2	5	270	77
	1988	328	147	15.7	102	201	328	32.3	10.4	12.4	78.8	328	3.41	0.51	3	5	327	73
	1989	288	152	21.3	98	238	288	35.0	14.0	9.8	123.2	288	3.25	0.53	2	5	288	79
	1990	271	148	21.2	100	253	271	30.5	13.1	10.3	122.8	271	3.29	0.49	2	5	271	74
	1991	246	153	19.9	104	244	246	33.5	13.6	12.6	112.5	246	3.19	0.44	2	5	245	66
	1992	169	149	15.6	116	189	169	30.1	8.9	14.9	59.2	169	3.28	0.51	2	5	169	71
	1993	246	149	16.5	114	198	246	31.6	10.3	15.7	71.7	246	3.26	0.45	3	5	246	67
	1994	208	148	15.1	116	190	208	29.6	8.3	16.0	59.2	208	3.20	0.41	2	4	208	74
	1995	249	143	15.2	103	179	249	28.6	8.3	10.3	50.6	249	3.31	0.51	2	5	249	73
	1996	243	151	16.0	102	224	243	32.9	10.2	16.3	93.8	243	3.16	0.47	2	5	243	73
	1997	380	148	16.2	114	233	380	30.9	11.0	14.9	105.8	380	3.21	0.45	2	5	380	75
TOTAL		3044	148	17.3	98	253	2899	31.4	11.2	9.8	123.2	3044	3.26	0.49	2	5	2896	73
1 SW	1986	357	506	23.0	440	570	357	1451	220.4	900	2900	357	3.38	0.57	2	5	356	76
	1987	373	509	23.3	430	580	373	1492	247.5	600	2600	373	3.18	0.46	2	5	352	79
	1988	267	506	26.1	440	600	267	1352	226.5	1000	2200	267	3.14	0.42	2	4	261	80
	1989	140	512	23.3	460	580	140	1411	201.7	1000	2000	140	3.18	0.50	2	5	135	79
	1990	174	508	23.4	449	575	142	1454	184.4	1100	2000	174	3.27	0.52	2	5	141	81
	1991	39	514	22.8	455	552	34	1362	172.4	1000	1700	39	3.18	0.39	3	4	33	70
	1992	77	505	22.4	453	580	36	1363	276.1	900	2000	77	3.18	0.53	2	5	43	79
	1993	39	513	30.8	475	620						39	3.05	0.32	2	4	0	
	1994 *	73	510	25.8	405	580	69	1272	193.9	800	1800	73	3.12	0.44	1	4	71	75
	1995 *	111	498	24.8	433	573	107	1144	184.4	800	1700	111	3.14	0.42	2	5	105	77
	1996	72	518	21.8	475	573	19	1523	219.1	1160	1920	72	3.22	0.51	2	5	2	100
	1997	163	514	22.1	460	590	39	1467	321.5	700	2000	163	3.24	0.48	2	5	39	82
TOTAL		1910	508	24.1	405	620	1608	1407	241.1	600	2900	1910	3.23	0.50	1	5	1538	78

* Samples of 1SW salmon in 1994 and 1995 were obtained from fish held for brood stock. Thus fish were sampled in September in each of these years.

Table 3. (Continued) Summary of biological characteristics for Atlantic salmon samples from Conne River, Newfoundland (SFA 11), 1986-1997.

Lifestage	Year	Fork length (mm)					Whole weight (g)					River age (y)					Sex Ratio	
		N	Mean	SD	Min	Max	N	Mean	SD	Min	Max	N	Mean	SD	Min	Max	N	% female
2 SW	1986	1	630				1	2600				1	3.00				1	100
	1989	2	665	21.2	650	680	1	2700				2	3.50	0.71	3	4	1	100
	1992	1	650				1	2700				1	4.00					
	1994	1	700									1	3.00					
	1995	2	735	49.5	700	770						2	3.00	0.00	3	3		
	1996	2	665	14.1	655	675						2	2.50	0.71	2	3		
	1997	1	740									1	3.00					
TOTAL		10	685	43.7	630	770	3	2667	57.5	2600	2700	10	3.10	0.57	2	4	2	100
Consecutive Spawning Grilse																		
	1986	1	560				1	1800				1	3.00				1	100
	1987	6	528	29.4	485	576	6	1578	351.8	1070	2100	6	3.17	0.75	2	4	5	100
	1988	5	556	24.1	530	590	5	1640	260.8	1500	2100	5	2.80	0.84	2	4	5	40
	1989	6	575	23.5	550	610	6	1767	233.8	1500	2000	6	3.00	0.00	3	3	6	50
	1990	3	564	51.4	505	601						3	3.33	0.58	3	4	0	
	1991	4	586	49.9	548	659	1	1400				4	3.50	0.58	3	4	1	100
	1992	8	581	43.6	530	660						8	3.50	0.53	3	4	0	
	1993	3	617	56.9	570	680						3	2.67	1.15	2	4	0	
	1994	15	564	36.1	510	640	14	1714	455.5	1200	2900	15	3.20	0.56	2	4	15	73
	1995	2	547	3.5	544	549	2	1500	141.4	1400	1600	2	3.00	0.00	3	3	2	100
	1996	19	572	60.8	505	795						19	3.16	0.37	3	4	2	50
	1997	52	582	37.0	510	665						52	3.21	0.50	2	4	0	
TOTAL		124	574	42.8	485	795	35	1671	350.1	1070	2900	124	3.19	0.53	2	4	37	70
Alternate Spawning Grilse																		
	1986	1	600				1	2400				1	3.00				1	100
	1989	13	683	18.9	660	710	2	3350	212.1	3200	3500	13	3.08	0.28	3	4	2	100
	1991	2	700	29.0	679	720						2	3.50	0.71	3	4	0	
	1992	8	682	44.4	630	770						8	2.88	0.35	2	3	1	100
	1993	6	675	35.1	640	710						6	3.33	0.52	3	4	0	
	1994	3	703	45.1	660	750						3	3.00	0.00	3	3	0	
	1995	5	730	29.2	710	780						5	3.00	0.00	3	3	0	
	1996	4	710	21.2	695	740						4	3.25	0.50	3	4	0	
	1997	19	702	30.9	655	780						19	3.21	0.42	3	4	0	
TOTAL		61	694	35.0	600	780	3	3033	568.6	2400	3500	61	3.13	0.39	2	4	4	100

Table 4. Summary of biological characteristics for Atlantic salmon samples from the Conne River aboriginal food fishery, 1988, 1992-93, and 1997.

Lifestage	Year	Fork length (mm)					Whole weight (g)					River age (y)					Sex Ratio	
		N	Mean	SD	Min	Max	N	Mean	SD	Min	Max	N	Mean	SD	Min	Max	N	% female
1 SW	1988	527	503	25.0	406	585	489	1397	219.0	600	2100	527	3.17	0.40	2	5	516	78
	1992	208	516	20.3	470	580	205	1389	176.6	1000	2000	208	3.07	0.44	2	5	206	67
	1993	253	504	24.3	430	640	253	1347	214.1	900	2400	253	3.08	0.39	1	4	253	67
	1997	472	529	23.6	460	610	472	1774	279.8	1000	2900	472	3.21	0.49	2	5	472	71
TOTAL		1460	513	26.5	406	640	1419	1512	299.2	600	2900	1460	3.15	0.44	1	5	1447	72
2 SW	1988	1	670				1	3300				1	4.00				1	100
	1992	1	690				1	2200				1	3.00				1	100
TOTAL		2	680	14.1	670	690	2	2750	777.8	2200	3300	2	3.50	0.71	3	4	2	100
Consecutive Spawning Grilse																		
	1988	11	591	58.6	518	733	9	2278	767.8	1300	3900	11	3.45	0.52	3	4	11	91
	1997	3	527	41.6	480	560	3	1367	152.8	1200	1500	3	4.00	0.00	4	4	3	100
TOTAL		14	578	60.6	480	733	12	2050	776.4	1200	3900	14	3.57	0.51	3	4	14	93
Alternate Spawning Grilse																		
	1992	2	685	7.1	680	670	2	3650	353.6	3400	3900	2	3.50	0.71	3	4	2	100
	1993	2	685	7.1	680	690	2	3550	212.1	3400	3700	2	3.00	0.00	3	3	2	100
	1997	1	690				1	4400				1	3.00				1	100
TOTAL		5	678	13	660	690	5	3760	415.9	3400	4400	5	3.20	0.45	3	4	5	100

Table 5. Numbers of small and large Conne River Atlantic salmon partitioned by life stage, and subsequent estimates of percent survival of previous spawning fish. Bracketed value for 1995 is preliminary pending alternate large salmon numbers in 1997.

	Small salmon			Large salmon			Percent survival of previous spawners
		Previous spawners			Previous spawners		
Year	1SW	Consecutive	Alternate	2SW	Consecutive	Alternate	
1986	8256	23	23	51	52	309	6.4
1987	10004	151	0	64	65	387	4.3
1988	7487	140	0	52	53	315	7.0
1989	4764	204	0	40	40	240	4.3
1990	5277	91	0	46	47	279	3.8
1991	2341	70	0	11	11	67	7.2
1992	2449	74	0	20	20	119	6.8
1993	2624	79	0	12	13	75	5.3
1994	1488	45	0	12	13	75	14.1
1995	3440	62	0	14	14	82	28.9
1996	3323	831	0	22	23	134	(19.4)
1997	2577	623	0	23	23	139	

* example of survival calculation from 8256 1SW salmon in 1986:

151 consecutive spawners from 1987 + 65 (large) consecutive spawners from 1987 + 315 (large) alternate spawners from 1988: = 531/8256 * 100 = 6.4%

1SW data for 1996 have been adjusted for the wild-aquacultured salmon that returned that year, i.e 3609 - 286 = 3323

1SW data for 1997 have included biological characteristic data from the Aboriginal food fishery to apportion fish into respective life history age classes.

Table 6. Mean number of eggs per female, length, weight data, and relative fecundity of Conne River Atlantic salmon.

Year		N	Number of eggs per female				Length (cm)				Weight (kg)				Relative Fecundity	
			Mean	STD	Min	Max	Mean	STD	Min	Max	Mean	STD	Min	Max	No. of eggs per cm	No. of eggs per kg
1987	*	30	2430	403	1796	3454	50.7	2.37	46.0	56.0	1.28	0.17	1.02	1.74	47.8	1907
1986		102	3494	682	1450	5590	50.9	2.37	45.0	56.0	1.48	0.23	1.00	2.90	68.7	2367
1987		136	3424	635	1287	5476	51.1	2.36	42.0	57.6	1.45	0.25	1.00	2.60	67.0	2364
1988		85	3196	568	2111	5054	50.2	2.50	46.0	60.0	1.35	0.24	1.00	2.20	63.7	2366
1990		93	2245	575	703	3544	51.1	2.09	46.0	57.0	1.45	0.18	1.10	2.00	44.0	1545
1991		22	2772	1241	595	5010	51.7	2.01	47.0	55.2	1.35	0.15	1.00	1.60	53.6	2046
1992		21	1768	498	1009	2545	50.6	2.15	45.3	55.2	1.38	0.25	0.90	1.90	35.0	1278
1997		33	3627	459	2929	5158	51.6	2.29	46.0	57.5	1.45	0.33	0.70	2.00	70.3	2504
Years Combined	**	492	3090	845	595	5590	50.9	2.33	42.0	60.0	1.43	0.24	0.70	2.90	60.7	2159

* These 1987 data were obtained from ripe salmon sampled at the end of October. For other years, samples were obtained primarily in June and July.

** Information from years combined does not include data from ripe salmon sampled in 1987.

Table 7. Summary of rainbow trout occurrences and captures at Conne River, 1997, with corresponding size data where available.

Year	Date	Location/gear	Length (mm)
1997	May 18	Smolt trap	546
	May 23	Smolt trap	
	June 1	Smolt trap	170
	June 3	Smolt trap	195
	June 4	Smolt trap	405
	June 17	Diving observation (N = 25)	150 - 500
	June 26	Diving observation (N = 8)	200 - 400
	July 1	Fence mortality	475
	July 2	Diving observation (N = 15)	200 - 400
	July 3	Adult trap	540
	July 9	Adult trap	300
	July 13	Diving observation (N = 3)	150 - 200
	July 26	Diving observation (N = 10)	200 - 500
	August 2	Fence mortality	520
	August 7	Adult trap	395

Table 8. Total estimated returns of small salmon to Conne River, Newfoundland, with a summary of mortalities and removals and estimated spawning escapement, 1986-97.

	Year											
	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
Returns												
* Food Fishery (estuary)	766	451	506	317	831	234	403	347	0	0	0	428
Angling below fence				180	213	70	137	0	0	0	0	95
Mortalities below fence	21	17	3	2	3	2	0	1	0	2	4	1
Count at fence	7515	9287	7118	4469	4321	2086	1973	2355	1533	3500	4436	2676
Estimated count		400				19	10					
Total Returns	8302	10155	7627	4968	5368	2411	2523	2703	1533	3502	4440	3200
1 - Released at fence	7515	9687	7118	4469	4321	2105	1983	2355	1533	3500	4436	2676
Removals and mortalities												
Mortalities above fence	27	21	7	4	2	5	8	2	5	7	9	5
Angling above fence	2060	1598	1544	856	554	38	192	0	0	0	0	102
Brood stock removal		245							93	117	25	
Farmed salmon removed												3
Hook and release mortalities												8
2 - Total	2087	1864	1551	860	556	43	200	2	98	124	34	118
Spawning escapement												
(1) - (2)	5428	7823	5567	3609	3765	2062	1783	2353	1435	3376	4402	2558
Egg deposition												
in millions of eggs	9.86	14.66	10.65	6.95	7.50	3.68	3.45	4.43	2.78	5.95	8.12	4.81
% of Management Target met	126	188	137	89	96	47	44	57	36	76	104	62
% of Conservation egg requirement met	227	338	246	160	173	85	80	102	64	137	187	111

* Food fishery includes fish caught in the estuary during tagging studies in 1986 and 1987. Proportions of Conne River origin salmon in 1986 and 1987 were 0.792 (N = 967) and 0.914 (N = 493), respectively. For remaining years, the weighted mean (0.833) was used.

Note: Results for 1994 are for wild fish only, and do NOT include any impact of the egg deposition 'equivalency' from fry reared in 1994-95. Count of small salmon in 1996 includes 286 fish that were derived from the release of the wild smolt aquaculture experiment.

Table 9. Total estimated returns of large salmon to Conne River, Newfoundland, with a summary of mortalities and removals and estimated spawning escapement, 1986-97. Total estimated egg deposition from small and large salmon are also indicated along with the combined estimate of the percentage of the Management Target or Conservation egg requirement met.

	Year											
	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
Returns												
* Food Fishery (estuary)	14	18	2	1	11	2	4	2	0	0	0	1
Angling below fence	0	0	0	0	0	0	0	0	0	0	0	0
Mortalities below fence	1	0	0	0	0	0	1	0	0	0	0	0
Count at fence	397	498	418	319	361	87	154	98	100	110	179	184
Estimated count												
Total Returns	412	516	420	320	372	89	159	100	100	110	179	185
1 - Released at fence	397	498	418	319	361	87	154	98	100	110	179	184
Removals and mortalities												
Mortalities above fence	1	0	0	0	0	0	1	1	0	2	0	0
Angling above fence	0	0	0	0	0	0	0	0	0	0	0	0
Brood stock removal		10							1	0	0	0
Farmed salmon removed												2
Hook and release mortalities												
2 - Total	1	10	0	0	0	0	1	1	1	2	0	2
Spawning escapement												
(1) - (2)	396	488	418	319	361	87	153	97	99	108	179	182
Egg deposition												
in millions of eggs	1.48	2.07	1.77	1.09	1.23	0.30	0.52	0.33	0.34	0.37	0.61	0.62
% of Management Target met	19	27	23	14	16	4	7	4	4	5	8	8
% of Conservation egg requirement met	34	48	41	25	28	7	12	8	8	9	14	14
Total egg deposition - small and large salmon	11.34	16.73	12.42	8.04	8.73	3.98	3.97	4.76	3.12	6.32	8.73	5.43
Egg deposition per unit fluvial habitat	860	1269	942	610	662	302	301	361	237	480	662	412
Total % Management Target met	145	214	159	103	112	51	51	61	40	81	112	70
Total % Conservation requirement met	261	386	286	185	201	92	92	110	72	146	201	125

* Food fishery includes fish caught in the estuary during tagging studies in 1986 and 1987. Proportions of Conne River origin salmon in 1986 and 1987 were 0.792 (N = 967) and 0.914 (N = 493), respectively. For remaining years, the weighted mean (0.833) was used.

One unit of fluvial habitat = 100 m^2.
Conne River has an estimated 13,160 units of accessible fluvial habitat.

Table 10. Estimates of Atlantic salmon smolts from Conne River, 1987 - 1997, along with subsequent survival to both small salmon in year i + 1, and to 1SW salmon (repeat spawning fish omitted).

	Number of smolts			Population estimate			Survival		
	Upper site	Lower site					% survival to small salmon year i + 1	Survival range	% survival to 1SW salmon year i + 1
Year (i)	Tagged & released	Total number Captured	Tag Recoveries	N	Confidence interval	Coeffiicient of variation %			
1987	4975	14314	990	74585	67597 - 81573	5.1	10.2	9.3 - 11.3	10.04
1988	3235	19515	1054	65692	59862 - 71522	4.8	7.6	6.9 - 8.3	7.25
1989	2699	16928	604	73724	66598 - 80850	5.1	7.3	6.7 - 8.1	7.16
1990	3719	13881	945	56943	52315 - 61571	4.4	4.2	3.9 - 4.6	4.11
1991	3753	9581	398	74645	62033 - 87527	9.0	3.4	2.9 - 4.1	3.28
1992	3758	10229	529	68208	61334 - 75052	5.4	4.0	3.6 - 4.4	3.85
1993	2456	15992	735	55765	51666 - 59864	3.9	2.7	2.6 - 3.0	2.67
1994	2366	11875	479	60762	53759 - 67765	6.2	5.8	5.2 - 6.5	5.66
1995	2558	12260	545	62749*	55300 - 70197	6.3	7.2	6.4 - 8.3	5.76
1996	3373	14575	499	94088	79867 - 108309	8.0	3.4	3.0 - 4.0	2.64
1997	3715	18290	662	100983	92812 - 109154	8.4			

* Of these fish, 5016 smolt were transferred to sea cage holding facilities at Roti Bay.

Table 11. Estimated total number of smolts in each age group, Conne River, Newfoundland, 1987-97. Lower chart indicates the percentage of smolts at each river age.

	River age (y)				
Year	2	3	4	5	Total
1987	1492	49226	22375	1492	74585
1988	0	40072	24963	657	65692
1989	2212	52344	17694	1474	73724
1990	569	39861	15944	569	56943
1991	747	59716	13436	746	74645
1992	682	49792	16370	1364	68208
1993	0	41266	14499	0	55765
1994	0	48002	12760	0	60762
1995	627	42670	18825	627	62749
1996	2823	75270	14113	1882	94088
1997	1010	79777	19186	1010	100983

	Percent in each age group				Number of
Year	2	3	4	5	samples
1987	2	66	30	2	271
1988	0	61	38	1	328
1989	3	71	24	2	288
1990	1	70	28	1	271
1991	1	80	18	1	246
1992	1	73	24	2	169
1993	0	74	26	0	246
1994	0	79	21	0	208
1995	1	68	30	1	249
1996	3	80	15	2	243
1997	1	79	19	1	380

Table 12. Marine thermal habitat units along with estimates of sea survival to small salmon or 1SW salmon at Conne River.

Year	Thermal habitat units								Sea survival	
	Jan	Feb	March	April	May	June	Jan-March	Jan-Feb	Small	1SW
1986	1832	1688	1547	1674	1880	2366	5067	3520		
1987	1711	1627	1471	1658	1655	1754	4809	3338		
1988	1747	1698	1622	1676	1864	2022	5067	3445	10.2	10.04
1989	1807	1642	1552	1552	1665	1985	5001	3449	7.6	7.25
1990	1526	1503	1491	1318	1543	1747	4520	3029	7.3	7.16
1991	1403	1357	1519	1529	1592	2050	4279	2760	4.2	4.11
1992	1474	1381	1378	1395	1582	1891	4233	2855	3.4	3.28
1993	1441	1252	1242	1353	1517	1923	3935	2693	4.0	3.85
1994	1487	1329	1373	1403	1711	1955	4189	2816	2.7	2.67
1995	1444	1311	1279	1378	1679	1941	4034	2755	5.8	5.66
1996	1647	1470	1419	1495	1859	2086	4536	3117	7.2	5.76
1997	1791	1594	1605	1714	1868	2071	4990	3385	3.4	2.64
1998	2018	1849	1795				5662	3867		

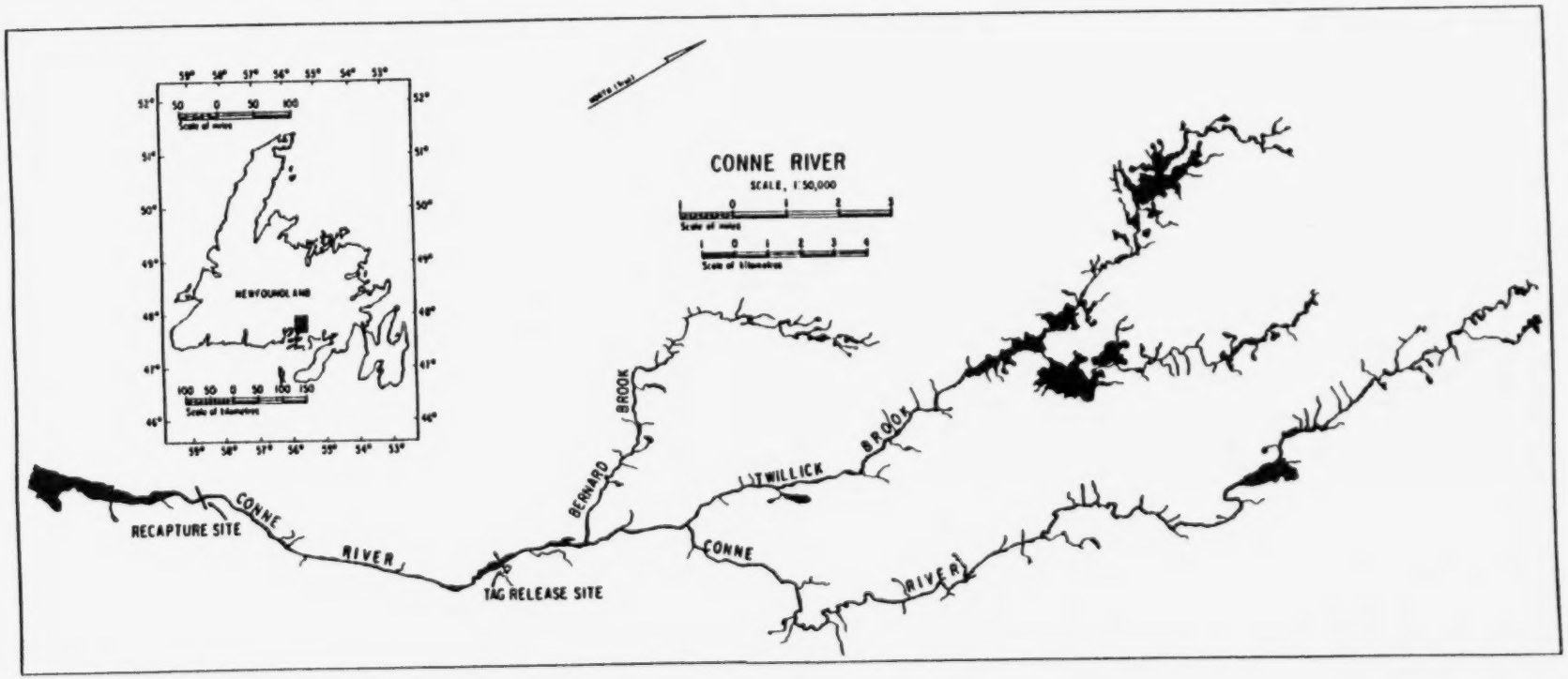

Fig. 1. Conne River, Newfoundland, SFA 11, illustrating the location of the fish counting fences used for the smolt mark-recapture survey. The recapture site is also the location of the upstream adult fish counting facility.

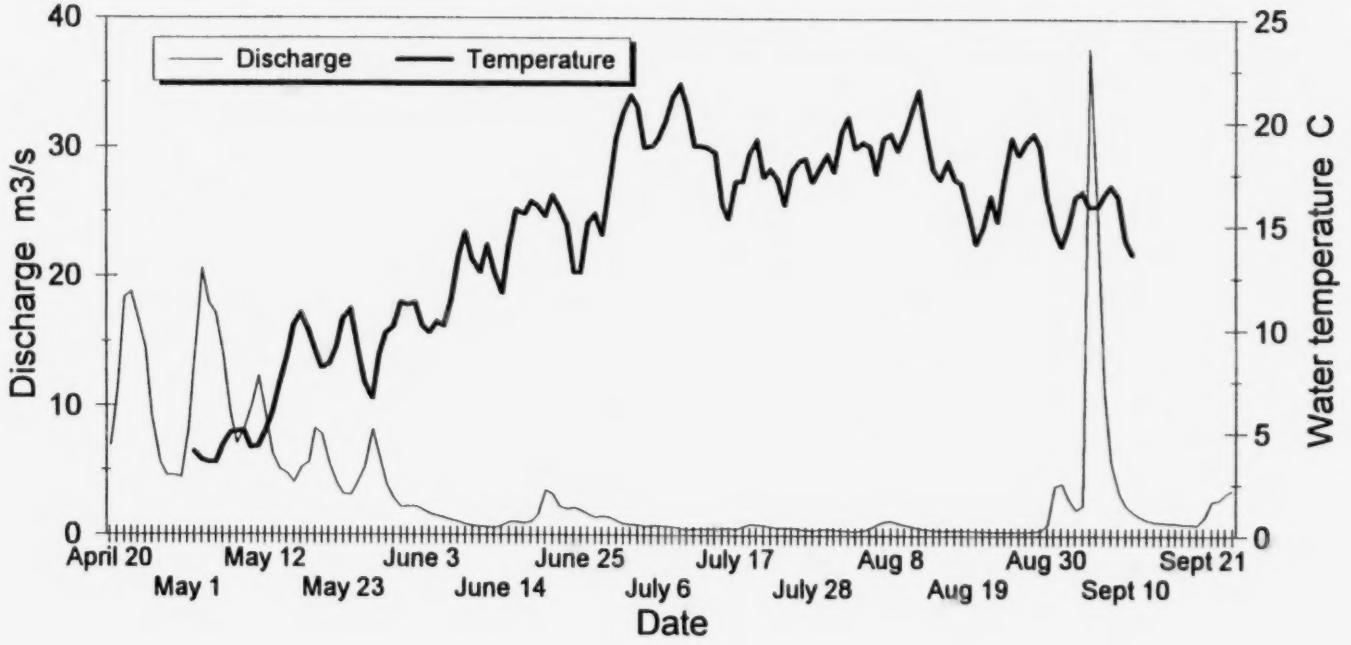

Figure 2. Discharge (April 20 - Sept. 25) and temperature (May 2 - Sept. 11) profile at Conne River, Newfoundland, 1997. Discharge data from the Environment Canada monitoring station located below Conne Pond. Temperature data from a Hugrun thermograph located at the lower (adult) fish counting fence site.

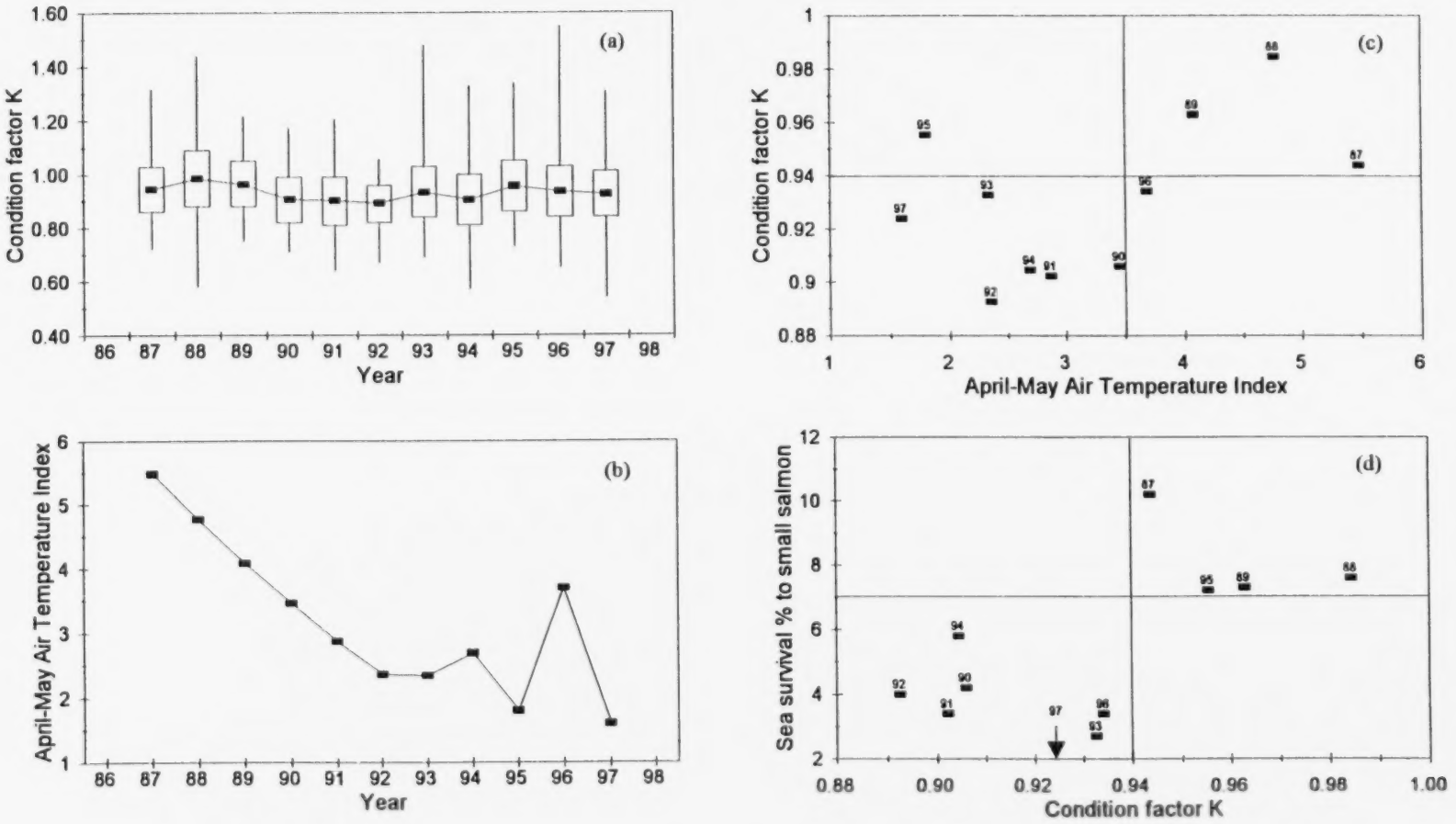

Figure 3. Trends in (a) Conne River smolt condition and (b) the April-May air temperature index over years; (c) smolt condition versus the air temperature index, and (d) sea survival (%) of small salmon versus smolt condition. Years shown refer to the year of smolt migration. In panel (d), the arrow indicates the 1997 smolt condition. In plot (a), vertical lines represent the minimum and maximum condition, the rectangle denotes one standard deviation about the mean which is the point within the rectangle.

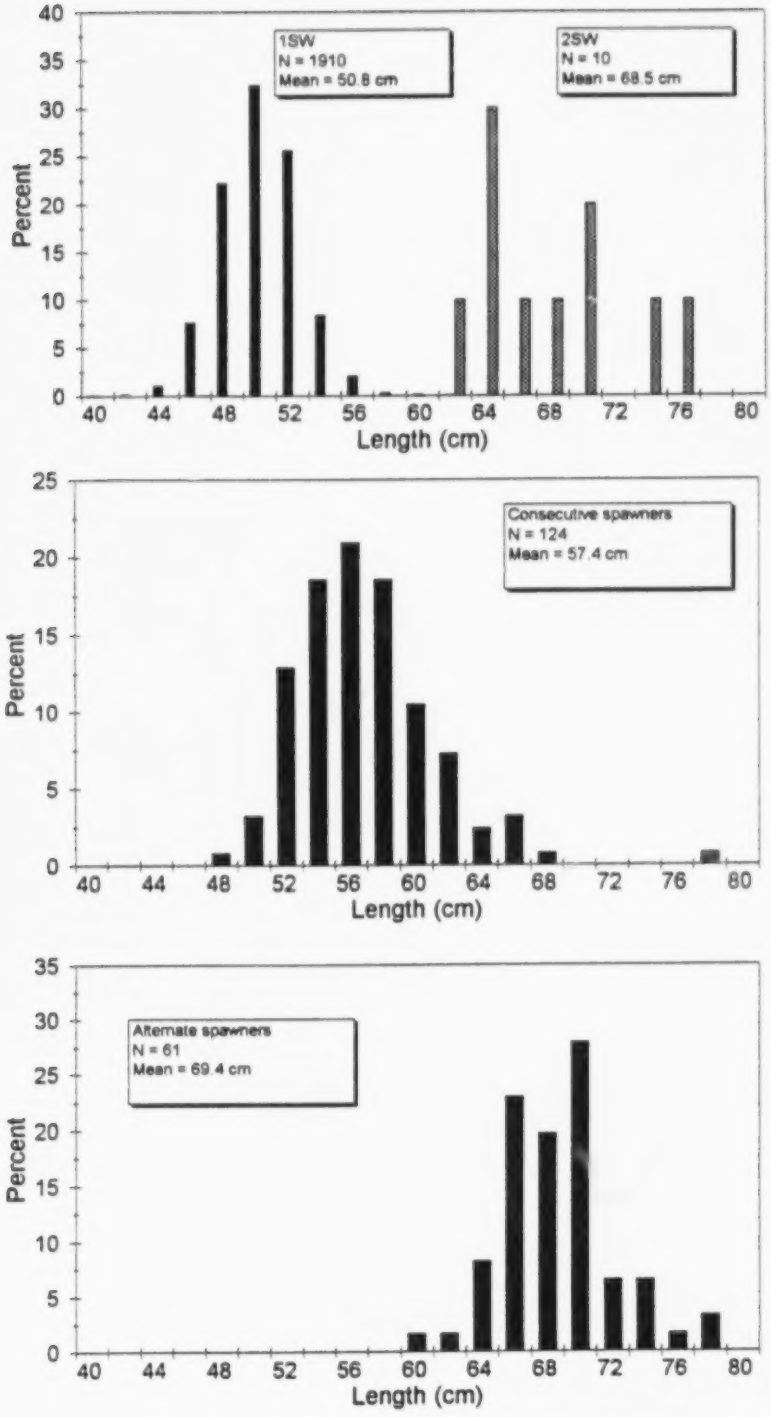

Figure 4. Length-frequency distribution of 1SW, 2SW, consecutive and alternate spawners, all years (1986-1997) combined, at Conne River, Newfoundland.

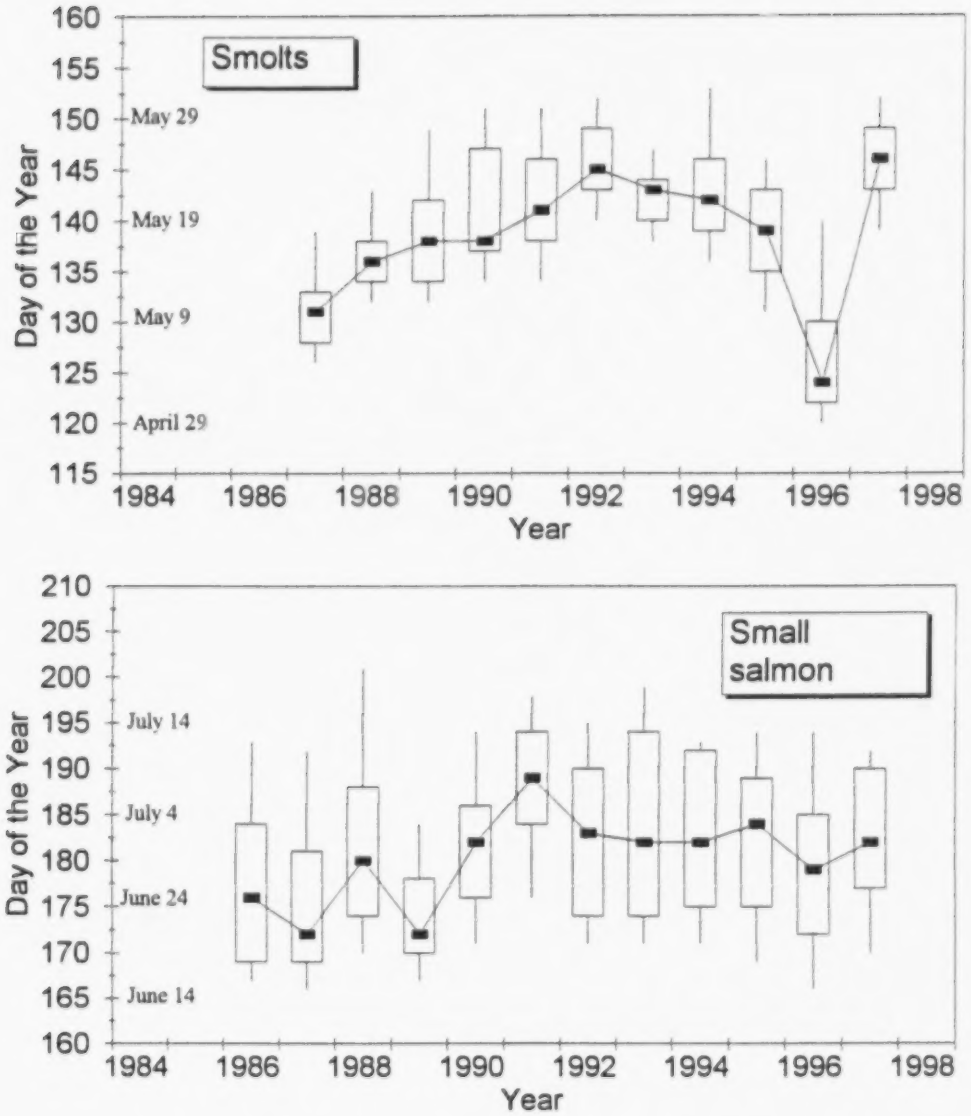

Figure 5. Annual variation in run timing at Conne River, Newfoundland, for Atlantic salmon smolts and returning small salmon. Vertical lines represent the 10th and 90th percentiles of the day of the year of migration, the rectangle is the 25th and 75th percentiles, and the marker within the rectangle is the median run timing value.

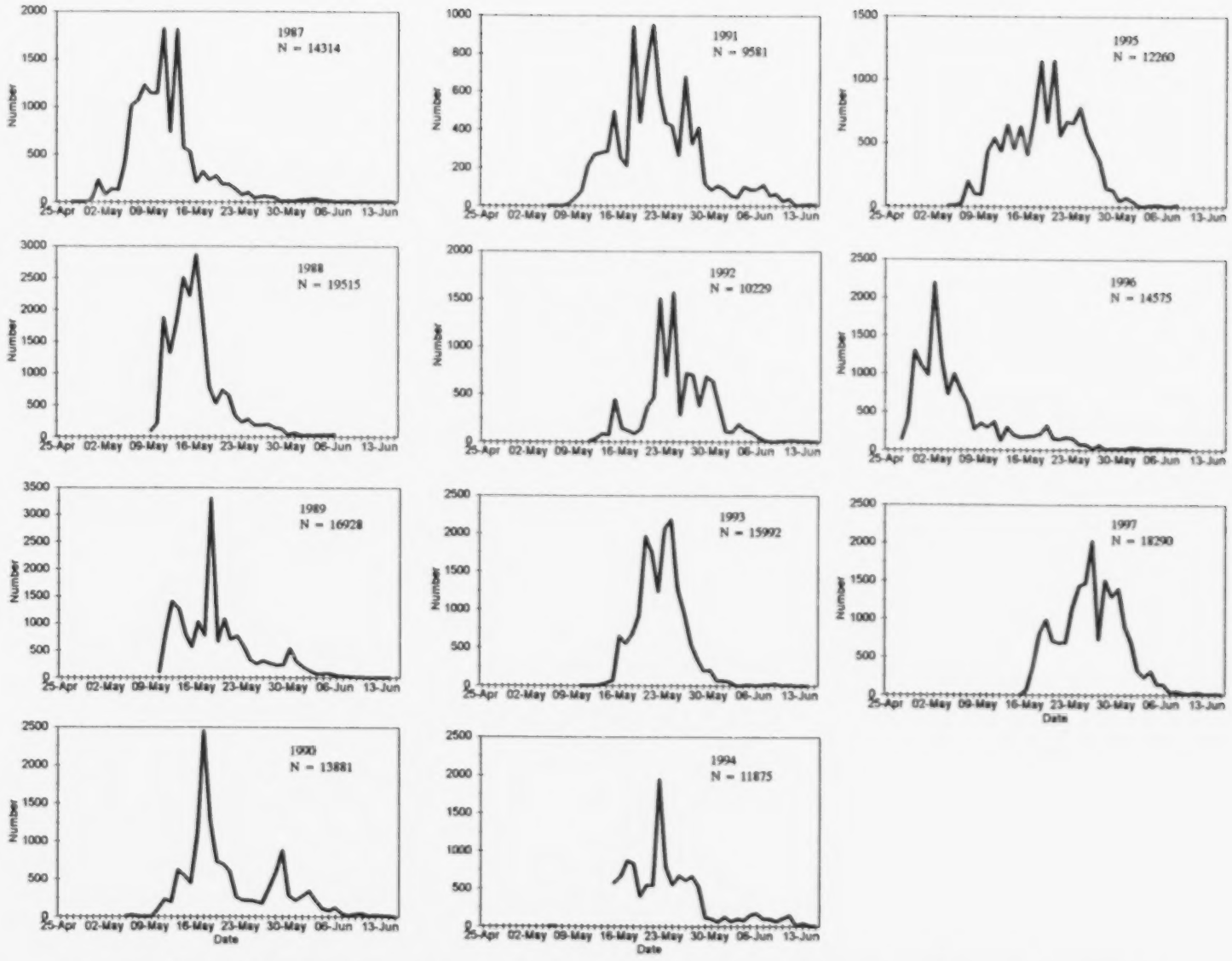

Figure 6. Numbers of Atlantic salmon smolts counted by day up to June 15 each year at the downstream fish counting fence trap at Conne River, Newfoundland, 1987 - 1997. N = total fence count of smolt for the season. Note that the total smolt population is estimated by mark-recapture.

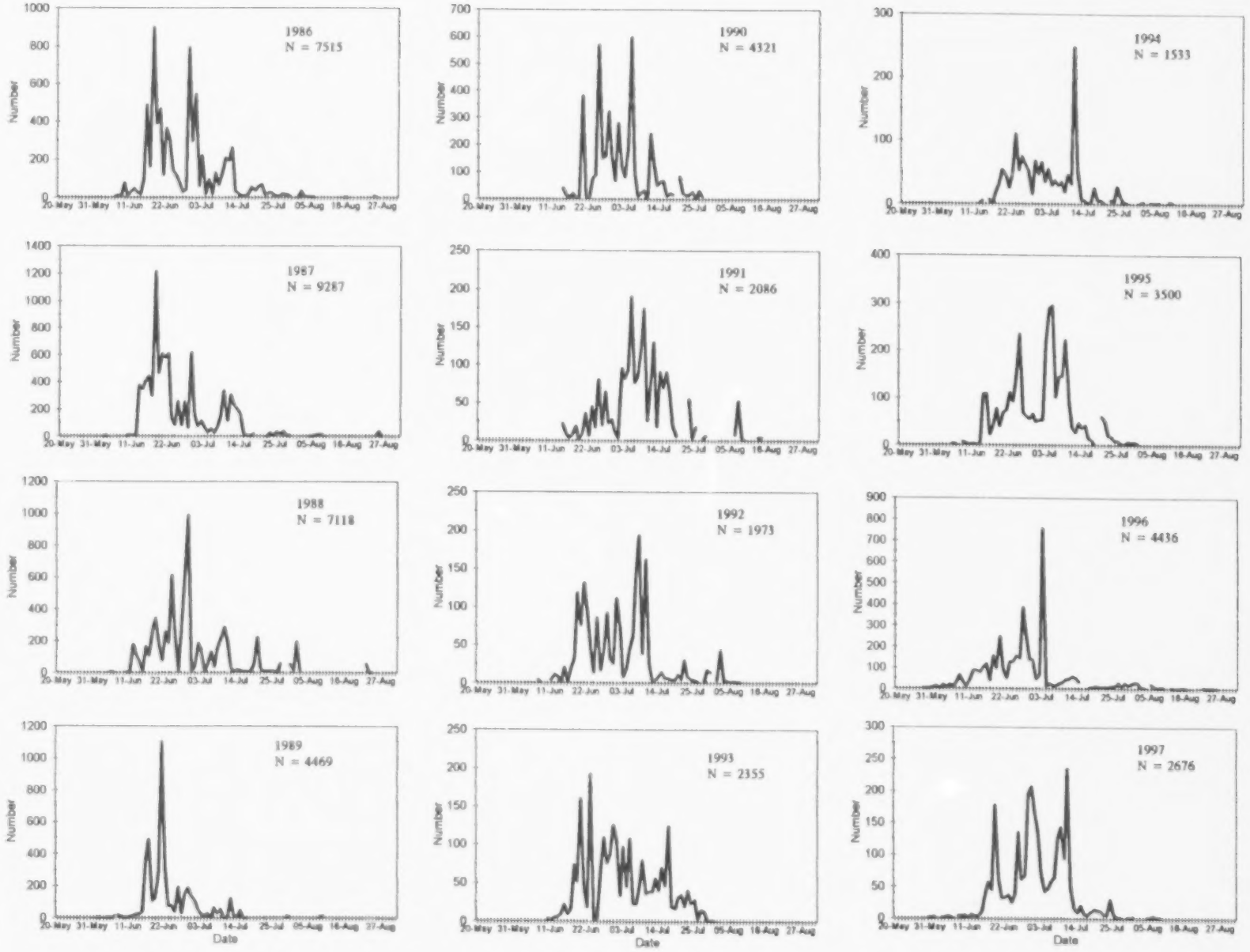

Figure 7. Numbers of small Atlantic salmon counted by day up to August 31 each year at the upstream fish counting fence at Conne River, Newfoundland, 1986 - 1997. N = total fence count of small salmon for the entire season

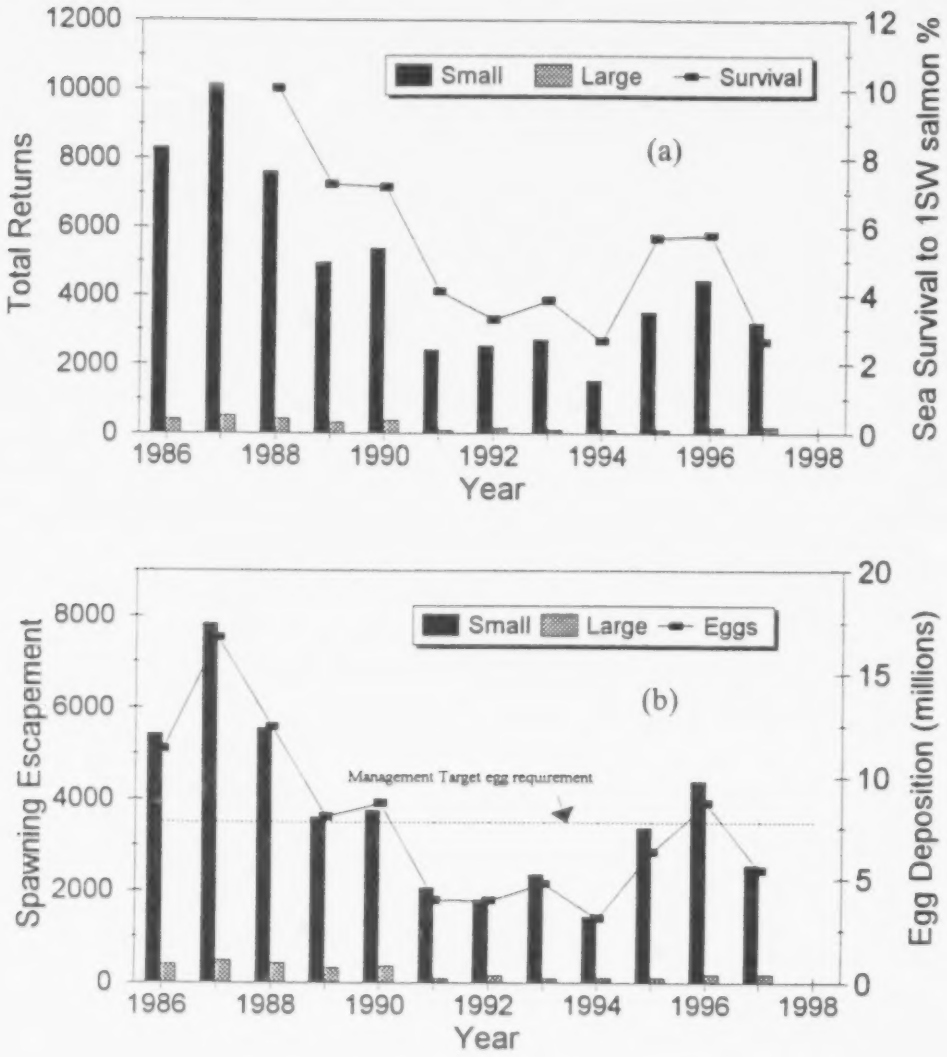

Figure 8. Total returns of small and large Atlantic salmon to Conne River, Newfoundland along with estimated sea survival from smolts to 1SW salmon (a). Survival estimates correspond to the year of adult return. Lower panel (b) illustrates the trend in spawning escapments and estimated egg deposition. The dashed horizontal line represents the current Management Target egg requirement.

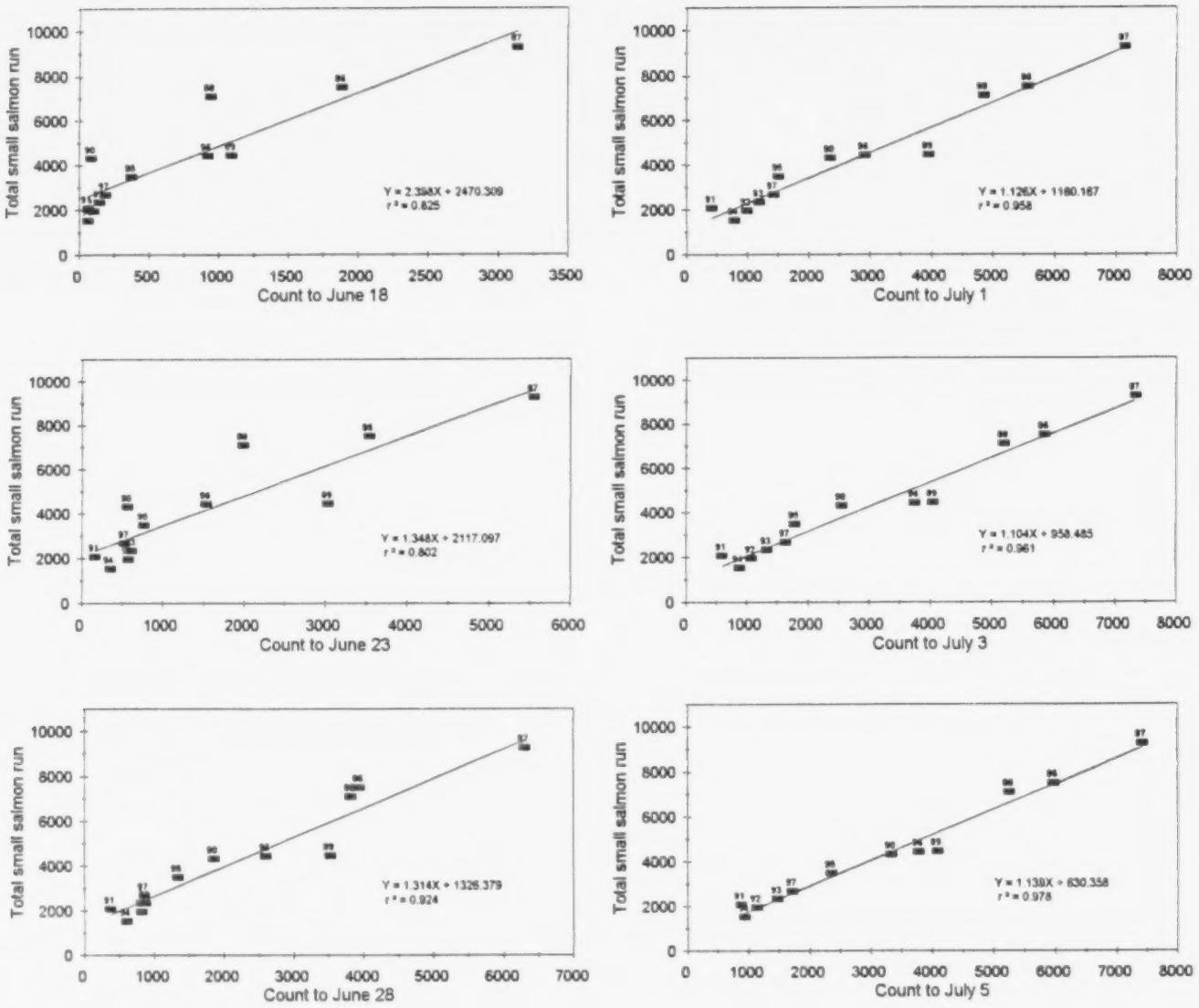

Figure 9. Regressions of cumulative counts of small salmon at various dates with the corresponding total counts of small salmon for the year, at Conne River, Newfoundland, 1986 - 1997.

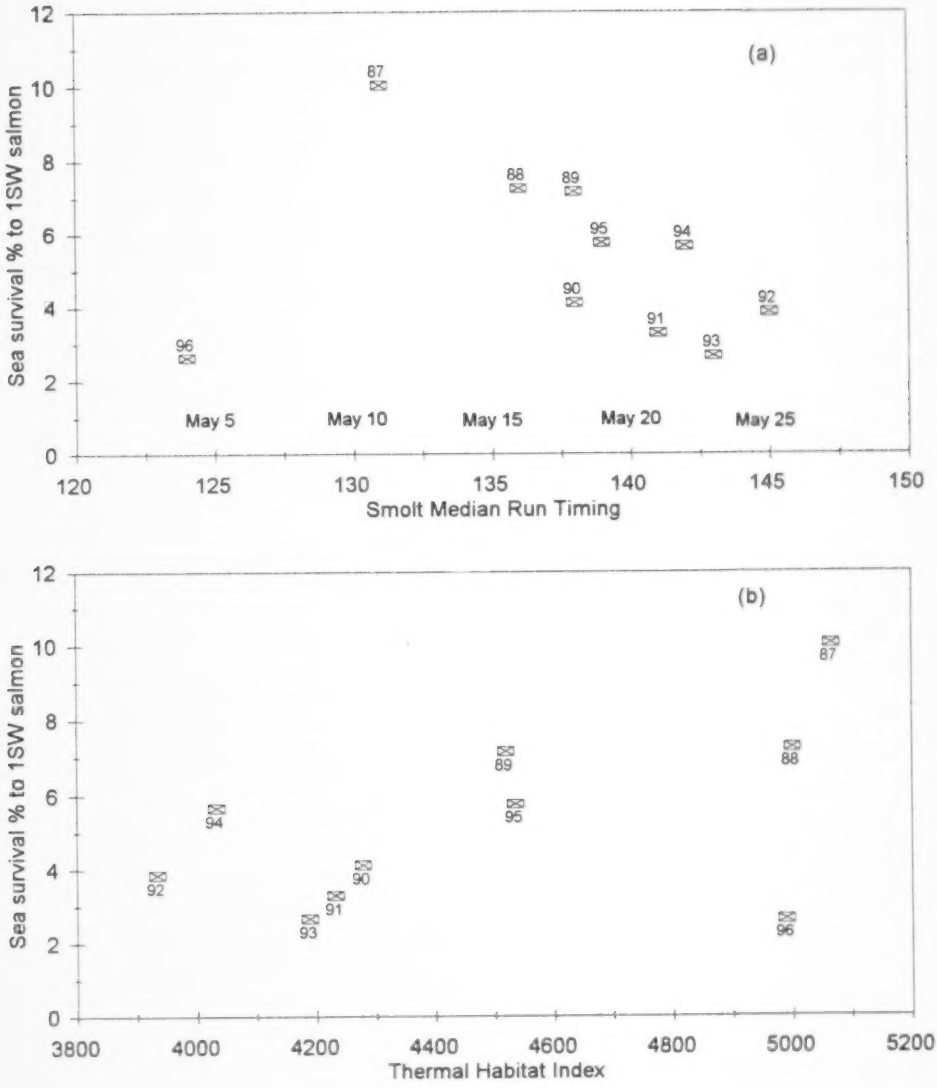

Figure 10. Scatter plots of: (a) median timing of the Conne River smolt run in year i with survival to 1SW salmon in year i+1; and (b) index of marine thermal habitat in year i (January - March) with sea survival to 1SW salmon returning in the same year. Years shown represent the smolt year class.

STOCK: Conne River (SFA 11) **Drainage area**: 602 km^2

MANAGEMENT TARGET: 7.8 million eggs (~4000 small salmon) calculated as fluvial area x 2.4 eggs/m^2 and egg/recruit applied to total population as derived from assumed commercial exploitation rates.

	1992	1993	1994	1995	1996	1997	MIN[1]	MAX[1]
Total Returns to home waters:								
Small	2523	2703	1533	3502	4440	3200	2411	10155
Large	159	100	100	110	179	185	89	516
First Peoples' harvest								
Small	483	417	0	0	0	514	0	948
Large	5	3	0	0	0	1	0	11
Recreational harvest (small salmon)								
Retained	329	0	0	0	0	197	0	3302
Released	-	0	0	0	0	80	0	80
Recreational harvest (large salmon)								
Retained	0	0	0	0	0	0	0	27
Released	-	0	0	0	0	0	0	0
Other mortalities								
Small salmon	8	3	5	9	13	6	3	48
Large salmon	2	1	1	2	0	0	0	2
Broodstock removal								
Small salmon	0	0	93	117	25	0	25	245
Large salmon	0	0	1	0	0	0	0	1
Spawners:								
Small	1783	2353	1435	3376	4402	2558	1435	7823
Large	153	97	99	108	179	182	87	488
Management target								
% eggs met:	51	61	40	81	112	70	40	214
Smolt estimate	68208	55765	60762	62749	94088	100983	55765	100983
% Sea Survival[2]	3.4	4.0	2.7	5.8	7.2	3.4	2.7	10.2

[1] Min, max are for the period of record since 1974. First Peoples harvest in salt water includes some salmon from other rivers. First Peoples fishery quota of 1200 fish has been in effect since 1986, but was reduced to 500 fish for 1993. First Peoples fishery was closed from 1994-96, while a preliminary allocation of 600 small salmon was provided in 1997 with a further allocation pending an inseason review of stock status.

[2] Sea survival is from smolt to small salmon returns in year of adult return.

Data and methodology: Smolts estimates are derived from mark-recapture surveys. Returning adult salmon are enumerated at a fish counting fence. Angling harvests for Conne River are from DFO statistics. A video camera system was introduced in 1993.

State of the stock: The Management Target, which is higher than the conservation egg requirement, was met from 1986-90 and again in 1996. Only 40-61% of the target was achieved from 1991-1994, rose to 81% in 1995 and was 70% in 1997. Sea survival to small salmon fell to the lowest value (3.4%) since 1993-94. In contrast with the Management Target, the Conservation egg requirement was met or exceeded from 1986-1990, in 1993, and again from 1995-1997.

Forecast: Estimated smolt output in 1997 was the highest on record: 100,983 (92,812-109,154). A sea survival of 4% would result in 4000 adult salmon returns in 1998. While survivals in the 7 - 10% range have occurred in the past, in recent years 1SW survival has remained low varying from 2.6 to 5.8%. Given the high variability in marine survival in recent years, and the late timing and lower condition of smolts in the 1997 run , a specific quantitative preseason forecast for 1998 is not provided.